We claim:

1. A sulfur-containing polyureaurethane adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured.
2. The sulfur-containing polyureaurethane of claim 1 wherein said Abbe number is at least 35.
3. The sulfur-containing polyureaurethane of claim 1 wherein said Abbe number is from 32 to 46.
4. The sulfur-containing polyureaurethane of claim 1 wherein said refractive index is at least 1.60.
5. The sulfur-containing polyureaurethane of claim 1 wherein said density is less than 1.25 grams/cm^3.
6. The sulfur-containing polyureaurethane of claim 1 wherein said density is from 1.15 to less than 1.3 grams/cm^3.
7. The sulfur-containing polyureaurethane of claim 1 further comprising an impact strength of at least 2 joules using the Impact Energy Test.
8. The sulfur-containing polyureaurethane of claim 1 that is prepared by the reaction of:
    (a) a sulfur-containing polyurethane prepolymer; and
    (b) an amine-containing curing agent.
9. The sulfur-containing polyureaurethane of claim 8 wherein the sulfur-containing polyurethane prepolymer comprises the reaction of:
    (a) a sulfur-containing polycyanate; and
    (b) an active hydrogen-containing material.
10. The sulfur-containing polyureaurethane of claim 9 wherein the sulfur-containing polycyanate comprises a polyisothiocyanate.
11. The sulfur-containing polyureaurethane of claim 9 wherein the sulfur-containing polycyanate comprises a mixture of a polyisothiocyanate and a polyisocyanate.

12. The sulfur-containing polyureaurethane of claim 9 wherein the active hydrogen-containing material comprises polyol free of sulfur.

13. The sulfur-containing polyureaurethane of claim 9 wherein the active hydrogen-containing material comprises polythiol.

14. The sulfur-containing polyureaurethane of claim 9 wherein the active hydrogen-containing material comprises a mixture of a polyol free of sulfur and a polythiol.

15. The sulfur-containing polyureaurethane of claim 9 wherein the active hydrogen-containing material is a hydroxyl functional polysulfide.

16. The sulfur-containing polyureaurethane of claim 15 wherein said hydroxyl function polysulfide further comprises SH-functionality.

17. The sulfur-containing polyureaurethane of claim 14 wherein said polyol free of sulfur is chosen from polyester polyols, polycaprolactone polyols, polyether polyols, polycarbonate polyols, and mixtures thereof.

18. The sulfur-containing polyureaurethane of claim 9 wherein said active hydrogen-containing material has a number average molecular weight of from 200 grams/molel to 32,000 grams/molel as determined by GPC.

19. The sulfur-containing polyureaurethane of claim 18 wherein said active hydrogen-containing material has a number average molecular weight of from about 2,000 to 15,000 grams/molel as determined by GPC.

20. The sulfur-containing polyureaurethane of claim 9 wherein said prepolymer has a thiocyanate to hydroxyl equivalent ratio of from 2.0 to less than 5.5.

21. The sulfur-containing polyureaurethane of claim 12 wherein said polyol free of sulfur comprises a polyether polyol.

22. The sulfur-containing polyureaurethane of claim 21 wherein said polyether polyol is represented by the following structural formula:

$$H-(O-CRRCRR-Y_n)_a-(CRRCRR-Y_n-O)_b-(CRRCRR-Y_n-O)_c-H$$

wherein R can represent hydrogen or C_1-C_6 alkyl; Y can represent CH_2; n can be an integer from 0 to 6; a, b, and c can each be an integer from 0 to 300, wherein a, b and c are chosen such that the number average molecular weight of the polyol does not exceed 32,000 grams/molel as determined by GPC.

23. The sulfur-containing polyureaurethane of claim 9 wherein said sulfur-containing polycyanate and said active hydrogen-containing material are present in an amount such that the molor equivalent ratio of (NCO + NCS) to (SH + OH) is less than 5.5 to 1.0.

24. The sulfur-containing polyureaurethane of claim 9 wherein said sulfur-containing polycyanate and said active hydrogen-containing material are present in an amount such that the molor equivalent ratio of (NCO + NCS) to (SH + OH + NR), wherein R is hydrogen or alkyl, is less than 5.5 to 1.0.

25. The sulfur-containing polyureaurethane of claim 8 wherein the sulfur-containing polyurethane prepolymer comprises the reaction of:

(a) a polyisocyanate; and

(b) a sulfur-containing active hydrogen material.

26. The sulfur-containing polyureaurethane of claim 25 wherein the polyisocyanate is chosen from aliphatic polyisocyanates, cycloaliphatic polyisocyanates, aromatic polyisocyanates, and mixtures thereof.

27. The sulfur-containing polyureaurethane of claim 25 wherein said polyisocyanate is chosen from aliphatic diisocyanates, cycloaliphatic diisocyanates, aromatic

diisocyanates, cyclic dimmers and cyclic trimers thereof, and mixtures thereof.

28. The sulfur-containing polyureaurethane material of claim 23 wherein said polyisocyanate is chosen from cyclohexylmethane and isomeric mixtures thereof.

29. The sulfur-containing polyureaurethane of claim 25 wherein said polyisocyanate is chosen from trans, trans isomer of 4,4'-methylenebis(cyclohexyl isocyanate).

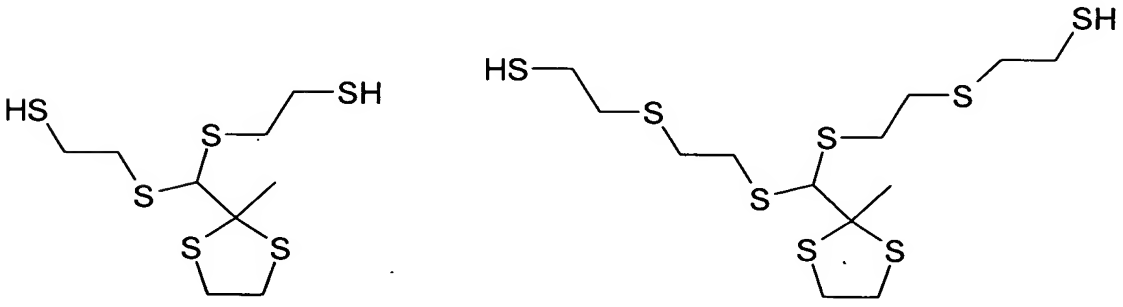
30. The sulfur-containing polyureaurethane of claim 25 wherein said polyisocyanate is chosen from 3-isocyanato-methyl-3,5,5-trimethyl cyclohexyl-isoxyanate; meta-tetramethylxylene diisocyanate (1,3-bis(1-isocyanato-1-methylethyl)-benzene) and mixtures thereof.

31. The sulfur-containing polyureaurethane of claim 25 wherein the sulfur-containing active hydrogen material is a SH-containing material.

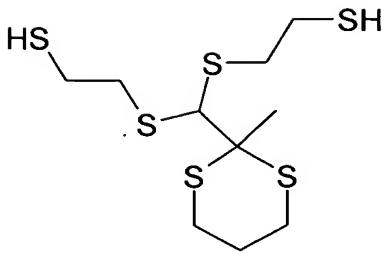
32. The sulfur-containing polyureaurethane of claim 31 wherein the SH-containing material is a polythiol.

33. The sulfur-containing polyureaurethane of claim 32 wherein said polythiol is chosen from aliphatic polythiols, cycloaliphatic polythiols, aromatic polythiols, polymeric polythiols, polythiols containing ether linkages, polythiols containing one or more sulfide linkages.

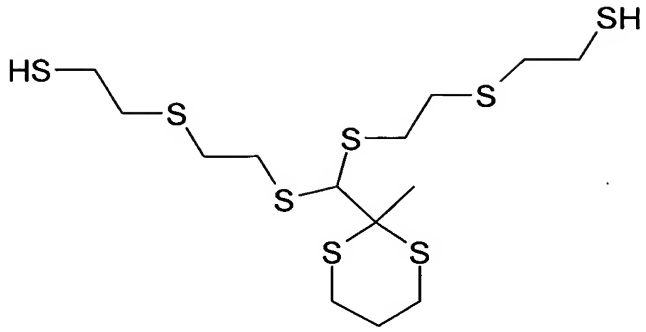
34. The sulfur-containing polyureaurethane of claim 32 wherein the polythiol comprises at least one material represented by the following structural formulas:



(IV'a)



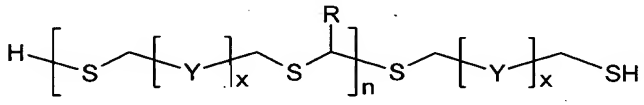
(IV'b)



(IV'c)

(IV'd)

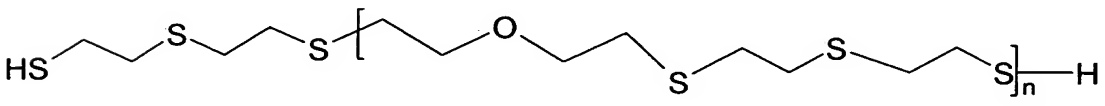
35. The sulfur-containing polyureaurethane of claim 32 wherein the polythiol comprises at least one material represented by the following structural formula:



(IV'e)

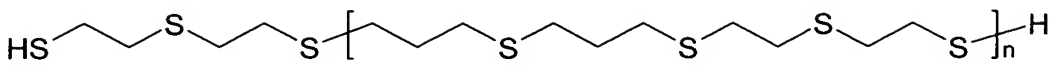
wherein R can represent CH_3, CH_3CO, C_1 to C_{10} alkyl, cycloalkyl, aryl alkyl, or alkyl-CO; Y can represent C_1 to C_{10} alkyl, cycloalkyl, C_6 to C_{14} aryl, $(CH_2)_p(S)_m(CH_2)_q$, $(CH_2)_p(Se)_m(CH_2)_q$, $(CH_2)_p(Te)_m(CH_2)_q$ wherein m can be an integer from 1 to 5 and, p and q can each be an integer from 1 to 10; n can be an integer from 1 to 30; and x can be an integer from 0 to 10.

36. The sulfur-containing polyureaurethane of claim 32 wherein the polythiol comprises at least one material represented by the following structural formulas:

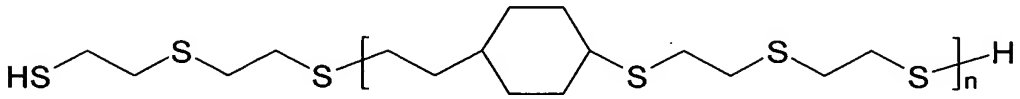


(IV'f)

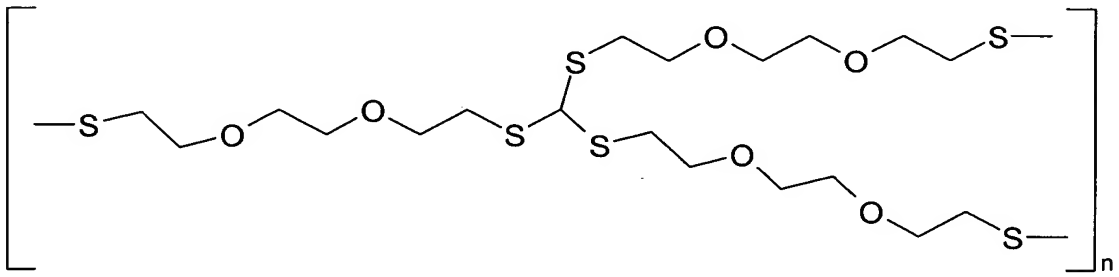
n



(IV'g)



(IV'h)



(IV'i)

wherein n can be an integer from 1 to 20.

37. The sulfur-containing polyureaurethane of claim 32 wherein the SH-containing material comprises a mixture of polythiol and polyol free of sulfur.

38. The sulfur-containing polyureaurethane of claim 25 wherein the sulfur-containing active hydrogen material is a hydroxyl functional polysulfide.

39. The sulfur-containing polyureaurethane of claim 38 wherein said hydroxyl functional polysulfide further comprises SH-functionality.

40. The sulfur-containing polyureaurethane of claim 8 wherein said amine-containing curing agent is a sulfur-containing amine-containing curing agent.

41. The sulfur-containing polyureaurethane of claim 1 that is prepared by the reaction of:

(a) a sulfur-containing polycyanate;

(b) an active hydrogen-containing material; and

(c) an amine-containing curing agent.

42. The sulfur-containing polyureaurethane of claim 41 wherein the sulfur-containing polycyanate comprises a polyisothiocyanate.

43. The sulfur-containing polyureaurethane of claim 41 wherein the sulfur-containing polycyanate comprises a mixture of a polyisothiocyanate and a polyisocyanate.

44. The sulfur-containing polyureaurethane of claim 41 wherein the active hydrogen-containing material comprises polyol free of sulfur.

45. The sulfur-containing polyureaurethane of claim 41 wherein the active hydrogen-containing material comprises polythiol.

46. The sulfur-containing polyureaurethane of claim 41 wherein the active hydrogen-containing material comprises a mixture of a polyol free of sulfur and a polythiol.

47. The sulfur-containing polyureaurethane of claim 44 wherein said polyol free of sulfur is chosen from polyester polyols, polycaprolactone polyols, polyether polyols, polycarbonate polyols, and mixtures thereof.

48. The sulfur-containing polyureaurethane of claim 44 wherein said active hydrogen-containing material has a number average molecular weight of from 200 to 32,000 grams/molel as determined by GPC.

49. The sulfur-containing polyureaurethane of claim 47 wherein said polyether polyol is represented by the following structural formula:

$$H-(O-CRRCRR-Y_n)_a-(CRRCRR-Y_n-O)_b-(CRRCRR-Y_n-O)_c-H$$

wherein R can represent hydrogen or C_1-C_6 alkyl; Y can represent CH_2; n can be an integer from 0 to 6; a, b, and c can each be an integer from 0 to 300, wherein a, b and

c are chosen such that the number average molecular weight of the polyol does not exceed 32,000 grams/molel as determined by GPC.

50. The sulfur-containing polyureaurethane of claim 1 that is prepared by the reaction of:

(a) a polyisocyanate;

(b) a sulfur-containing active hydrogen material; and

(c) an amine-containing curing agent.

51. The sulfur-containing polyureaurethane of claim 50 wherein said amine-containing curing agent is a sulfur-containing amine-containing curing agent.

52. The sulfur-containing polyureaurethane of claim 50 wherein the polyisocyanate is selected from aliphatic polyisocyanates, cycloaliphatic polyisocyanates, aromatic polyisocyanates, and mixtures thereof.

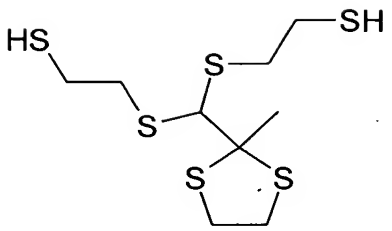
53. The sulfur-containing polyureaurethane of claim 50 wherein said polyisocyanate is chosen from aliphatic diisocyanates, cycloaliphatic diisocyanates, aromatic diisocyanates, cyclic dimmers and cyclic trimers thereof, and mixtures thereof.

54. The sulfur-containing polyureaurethane of claim 50 wherein the sulfur-containing active hydrogen material is a SH-containing material.

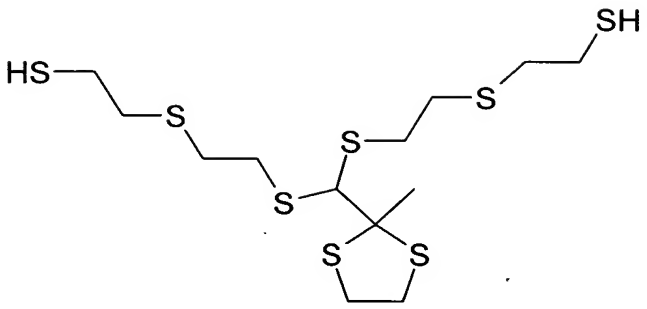
55. The sulfur-containing polyureaurethane of claim 54 wherein the SH-containing material is a polythiol.

56. The sulfur-containing polyureaurethane of claim 44 wherein said polythiol is chosen from aliphatic polythiols, cycloaliphatic polythiols, aromatic polythiols, polymeric polythiols, polythiols containing ether linkages, polythiols containing one or more sulfide linkages.

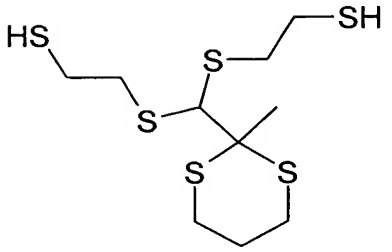
57. The sulfur-containing polyureaurethane of claim 55 wherein the polythiol comprises at least one of the following materials:



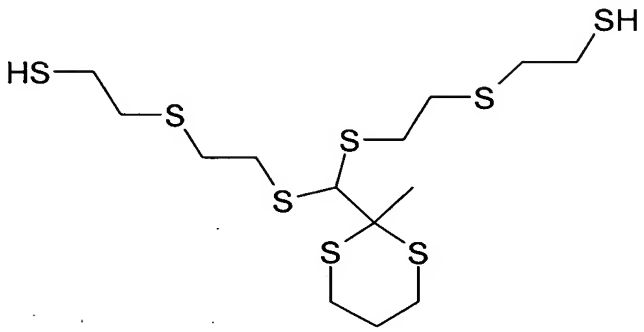
(IV'a)



(IV'b)

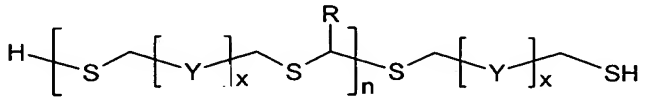


(IV'c)



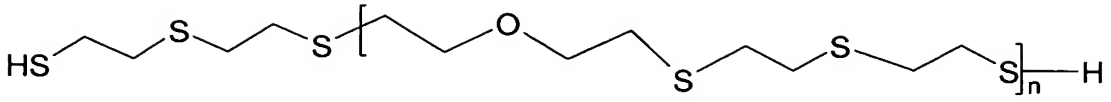
(IV'd)

58. The sulfur-containing polyureaurethane of claim 55 wherein the polythiol comprises at least one material represented by the following structural formula:



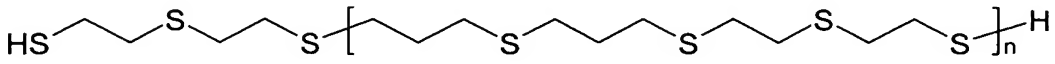
wherein R can represent CH_3, CH_3CO, C_1 to C_{10} alkyl, cycloalkyl, aryl alkyl, or alkyl-CO; Y can represent C_1 to C_{10} alkyl, cycloalkyl, C_6 to C_{14} aryl, $(CH_2)_p(S)_m(CH_2)_q$, $(CH_2)_p(Se)_m(CH_2)_q$, $(CH_2)_p(Te)_m(CH_2)_q$ wherein m can be an integer from 1 to 5 and, p and q can each be an integer from 1 to 10; n can be an integer from 1 to 20; and x can be an integer from 0 to 10.

59. The sulfur-containing polyureaurethane of claim 55 wherein the polythiol comprises at least one of the following materials:

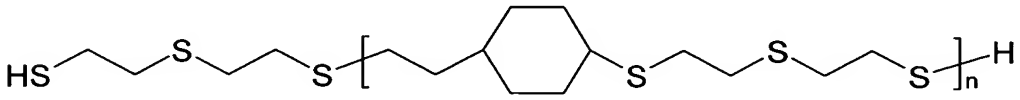


(IV'f)

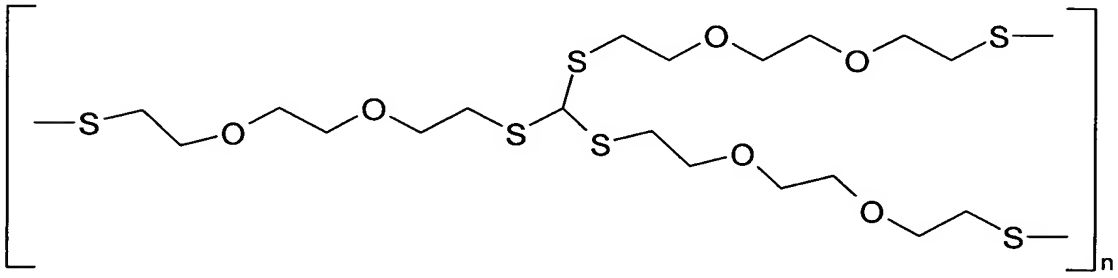
n



(IV'g)



(IV'h)



(IV'i)

wherein n can be an integer from 1 to 20.

60. The sulfur-containing polyureaurethane of claim 54 wherein the SH-containing material comprises a mixture of polythiol and polyol free of sulfur.

61. The sulfur-containing polyureaurethane of claim 50 wherein the sulfur-containing active hydrogen material is a hydroxyl functional polysulfide.

62. The sulfur-containing polyureaurethane of claim 61 wherein said hydroxyl functional polysulfide further comprises SH-functionality.

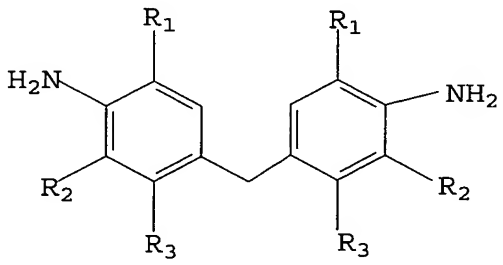
63. The sulfur-containing polyureaurethane of claim 50 wherein said amine-containing curing agent is a

mixture of amine-containing curing agent and at least one material chosen from polythiol and polyol.

64. The sulfur-containing polyureaurethane of claim 8 wherein said amine-containing curing agent is a polyamine having at least two functional groups independently chosen from primary amine ($-NH_2$), secondary amine (-NH-), and combinations thereof.

65. The sulfur-containing polyureaurethane of claim 64 wherein said polyamine is chosen from aliphatic polyamines, cycloaliphatic polyamines, aromatic polyamines, and mixtures thereof.

66. The sulfur-containing polyureaurethane of claim 64 wherein said polyamine is represented by the following structural following formula and mixtures thereof:



wherein R_1 and R_2 are each independently chosen from methyl, ethyl, propyl, and isopropyl groups, and R_3 is chosen from hydrogen and chlorine.

67. The sulfur-containing polyureaurethane of claim 6 wherein said amine-containing curing agent is 4,4'-methylenebis(3-chloro-2,6-diethylaniline).

68. The sulfur-containing polyureaurethane of claim 6 wherein said amine-containing curing agent is chosen from 2,4-diamino-3,5-diethyl-toluene; 2,6-diamino-3,5-diethyl-toluene and mixtures thereof.

69. The sulfur-containing polyureaurethane of claim 6 wherein said amine-containing curing agent has a NCO/NH_2 equivalent ratio of from 1.0 NCO/0.60 NH_2 to 1.0 NCO/1.20 NH_2.

70. A sulfur-containing polyureaurethane adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured, that is prepared by the reaction of:

(a) a polyurethane prepolymer; and

(b) an amine-containing curing agent,

wherein at least one of (a) and (b) is a sulfur-containing material.

71. The sulfur-containing polyureaurethane of claim 70 wherein said polyurethane prepolymer comprises the reaction of:

(a) polycyanate; and

(b) active hydrogen-containing material.

72. The sulfur-containing polyureaurethane of claim 71 wherein said polycyanate is chosen from polyisocyanate, polyisothiocyanate, and mixtures thereof.

73. The sulfur-containing polyureaurethane of claim 71 wherein said active hydrogen material is chosen from polyols, polythiols, and mixtures thereof.

74. The sulfur-containing polyureaurethane of claim 70 wherein said amine-containing curing agent is a polyamine having at least two functional groups independently chosen from primary amine ($-NH_2$), secondary amine (-NH-), and combinations thereof.

75. A method of preparing a sulfur-containing polyureaurethane comprising:

(a) reacting a sulfur-containing polycyanate and an active hydrogen-containing material to form a polyurethane prepolymer; and

(b) reacting said polyurethane prepolymer with an amine-containing curing agent,

wherein adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured.

76. The method of claim 75 further comprising reacting said polyurethane prepolymer in step (a) with an episulfide-containing material.

77. The method of claim 75 wherein said sulfur-containing polycyanate comprises a polyisothiocyanate.

78. The method of claim 75 wherein said sulfur-containing polycyanate comprises a mixture of polyisothiocyanate and polyisocyanate.

79. The method of claim 75 wherein said active hydrogen-containing material comprises a polyol free of sulfur.

80. The method of claim 75 wherein said active hydrogen-containing material comprises polythiol.

81. The method of claim 75 wherein said active hydrogen-containing material comprises a mixture of polyol free of sulfur and polythiol.

82. A method of preparing a sulfur-containing polyureaurethane comprising:

(a) reacting a polyisocyanate with a sulfur-containing active hydrogen-containing material to form a polyurethane prepolymer; and

(b) reacting said polyurethane prepolymer with an amine-containing curing agent,

wherein adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured.

83. The method of claim 82 wherein said polyisocyanate is chosen from aliphatic polyisocyanates, cycloaliphatic polyisocyanates, aromatic polyisocyanates, and mixtures thereof.

84. The method of claim 82 wherein said sulfur-containing active hydrogen-containing material is a SH-containing material.

85. The method of claim 84 wherein said SH-containing material is a polythiol.

86. The method of claim 84 wherein said SH-containing material comprises a mixture of a polythiol and a polyol free of sulfur.

87. The method of claim 82 wherein said sulfur-containing active hydrogen-containing material is a hydroxyl functional polysulfide.

88. The method of claim 82 wherein said amine-containing curing agent is a sulfur-containing amine-containing curing agent.

89. An optical article comprising a sulfur-containing polyureaurethane, wherein said polyureaurethane is adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured.

90. An ophthalmic lens comprising a sulfur-containing polyureaurethane, said polyureaurethane is adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured.

91. A photochromic article comprising a sulfur-containing polyureaurethane, wherein said polyureaurethane is adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3.

92. The photochromic article of claim 91 wherein it comprises an at least partially cured substrate, and at least a photochromic amount of a photochromic substance.

93. The photochromic article of claim 92 wherein said photochromic substance is at least partially imbibed into said substrate.

94. The photochromic article of claim 92 wherein said substrate is at least partially coated with a coating composition comprising at least a photochromic amount of a photochromic substance.

95. The photochromic article of claim 92 wherein said photochromic substance comprises at least one naphthopyran.

96. The photochromic article of claim 92 wherein said photochromic substance is chosen from spiro(indoline)naphthoxazines, spiro(indoline)benzoxazines, benzopyrans, naphthopyrans, organo-metal dithizonates, fulgides and fulgimides, and mixtures thereof.

97. A photochromic article comprising a sulfur-containing polyureaurethane, an at least a partially cured substrate, a photochromic amount of a photochromic material wherein said photochromic is at least partially imbibed into said substrate, and wherein said article is characterized by a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured.

98. A photochromic article comprising a sulfur-containing polyureaurethane, an at least partially cured substrate, wherein said substrate is at least partially coated with a coating composition comprising at least a photochromic amount of a photochromic material, and wherein said polyureaurethane is adapted to have a refractive index of at least 1.57, an Abbe number of at least 32 and a density of less than 1.3 grams/cm^3, when at least partially cured.